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Integrating Measurement Approaches in Gain Sharing and Total Quality

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Productivity Gain Sharing and Total Quality Management are two highly successful approaches to increasing productivity and improving quality. This report provides a synthesis of the literature and develops an integrated definition and approach.

The first part of this report discusses the concepts of productivity and quality (how they are defined), the different perspectives (how they are measured), and shows how the two concepts are interrelated. The second part focuses on some of the causes of the productivity and quality problems in the United States and provides keys to reducing these problems.

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Foreword

In general the rate of productivity growth has slowed in the United States since the 1970's. Since productivity is essential to the health of our economy and therefore the key to a continued high standard of living, productivity growth is critical to the well-being of future generations of Americans. This report reviews the concepts of productivity and quality and shows how they can be integrated. Productivity and quality are then related to two highly successful approaches to organizational improvement: Productivity Gain Sharing (PGS) and Total Quality Management (TQM). In addition, the report describes the major causes of productivity and quality problems in the U.S. and discusses some ways to solve these problems.

This report is one of a series of reports that integrate PGS and TQM. Other reports in this series are (1) *A Model for Continuous Organizational Improvement: Integrating Gain Sharing and Total Quality* (Nebeker, Wolosin & Tatum, 1996), (2) *An Approach to Measurement of Quality and Productivity for Gain Sharing: Measuring Total Organizational Value* (Nebeker & Tatum, 1996), (3) *Examples of White Collar Measurement Using a Typology of Organizational Effectiveness* (Nebeker, Tatum & Wolosin, 1996), and (4) *Using Performance Indexing to Measure Organizational Gains in a White Collar Environment* (Tatum, Nebeker & DeYoung, 1996).

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Summary

Problem and Background

Increasing productivity and improving quality will become a necessity in the future for Federal agencies as a result of Vice President Al Gore's 7 September 1993 report "*From Red Tape to Results: Creating a Government that Works Better and Costs Less.*" It has been recommended that quality management "basic training" be provided for all employees. Before agencies can provide this training, the definition and measurement of productivity and quality must be clear.

Objective

The purpose of this report is to provide a synthesis of the productivity and quality literature and develop an integrated definition and approach. This integration of Productivity Gain Sharing and Total Quality Management will provide the user with a better understanding of how these two approaches are compatible in their goals and methods of achieving organizational effectiveness.

Approach

The first part of this report discusses the concepts of productivity and quality (how they are defined), the different perspectives (how they are measured), and shows how the two concepts are interrelated and that both are essential to improving America's competitive position in the world economy. The second part focuses on some of the causes of productivity and quality problems in the United States, and provides keys to solving these problems.

Conclusion

Although there is much confusion surrounding the topic of the definition and measurement of productivity and quality, the importance of each is evident in the U.S. and world today. Many scholars have developed measurement systems reflecting their perspectives on productivity and quality. Regardless of the measurement system that an organization chooses to adopt, the primary focus should be on total organizational productivity and quality improvement.

Contents

Introduction

The rate of productivity growth has been slowing in the United States. Some authors believe this slowing began by 1970 (Brief, 1984; Riggs & Felix, 1983), while others state the decline began in the latter half of the 1970s (Donnelly, Gibson, & Ivancevich, 1987; Mahoney, 1988; Shetty & Buehler, 1985; Tuttle, 1983). Regardless of the beginning date, by the 1980s there was general acceptance of the fact that slowing had occurred, and the country's productivity problem was being discussed in many settings and media.

Since productivity is essential to the health of our economy and therefore the key to a continued high standard of living, productivity growth is critical to the well-being of future generations of Americans. Increases in wages and salaries, in operation costs, and in prices, all contribute to inflation, unless there are concomitant productivity gains. Scarce or expensive resources can be conserved with more productive usage and less waste of these resources. Writers from Adam Smith's time (late 18th century) to today agree that only by productivity improvement can the wealth of a nation increase.

Despite the decline in productivity growth, the U.S. is still the most productive country in the world. This productivity leadership is being challenged today by countries (most notably Japan) who have dominated certain markets (e.g., electronics) with high quality, competitively priced goods and services. It has become clear since the 1980s that productivity and quality are interrelated concepts, and U.S. companies have made enormous strides in adopting quality improvements to drive down the cost of making and distributing their products and services. The companies that will dominate the markets in the 1990s and beyond will be those that can deliver high-quality, competitively priced products just when the customer wants them, and in a way that meets the needs of customers and exceeds their expectations (Ciampa, 1992).

Two highly successful approaches to increasing productivity and improving quality are Productivity Gain Sharing (PGS) and Total Quality Management (TQM). Although PGS and TQM seem to be very different approaches to improving organizational effectiveness, they are actually very compatible (Landau & Tatum, 1992). The main purpose of this report is to review the different perspectives on productivity and quality, and attempt to integrate them. This syntheses will proceed in two parts.

The first part of this report will discuss the concepts of productivity and quality, and show that the two concepts are interrelated. The discussion will be a general review of productivity and quality (for a more specific treatment of these issues, see related reports by Nebeker & Tatum, 1996; Nebeker, Tatum, & Wolosin, 1996; Nebeker, Wolosin, & Tatum, 1996; Tatum, Nebeker, & DeYoung, 1996). This first part will conclude with a definition of productivity that combines traditional ideas about productivity with more recent concepts of quality.

The last part of this report will focus on some of the causes of the productivity and quality problems in the United States, and some keys to solving these problems. An understanding of productivity and quality, and how these concepts fit hand in glove, is critical to an understanding of how PGS and TQM can be adopted to improve the total performance of an organization.

Definitions and Perspectives

Definitions of Productivity

Productivity is defined in a variety of ways, as illustrated by the following set of definitions:

> Productivity is the relationship between the outputs generated from a system and the inputs provided to create those outputs (Sink, 1985, p.3).
>
> Productivity is the measure of how specified resources are managed to accomplish timely objectives stated in terms of quality and quantity (Riggs & Felix, 1983, p. 4).
>
> Productivity is the rate of transformation of inputs into outputs in a system of production or output/input (Mahoney, 1984, p. 56).
>
> Productivity is the ratio of the outputs produced for use outside of an organization, with due allowances for the different kinds of products, divided by the resources used, all divided by a similar ratio from a base period (Mundel, 1982, p. 1.5.1).
>
> Productivity relates to performance efficiency, not to outcome performance or effectiveness (Mahoney, 1988, p. 20).
>
> . . . the broad definition of productivity as efficiency and effectiveness is preferable (Tuttle, 1983, p. 483).
>
> Productivity is how well a system uses its resources to achieve its goals (Pritchard, 1990, p. 35).

The differences in the definitions evolve from differences in academic disciplinary perspectives and the purposes of productivity measurement. That is, the economist views productivity and its measurement differently from the industrial engineer—their purposes in developing measures differ, the knowledge and tools they have differ, and thus the resulting approaches to defining and measuring productivity are different. Reviewing the various perspectives and purposes of productivity measurement is helpful in understanding why such a plethora of productivity definitions exist.

Perspectives on Productivity

Economics

From an economist's view, the concept "productivity" expresses the relationship between outputs and the inputs required for its production. In the classical economic sense, productivity is usually expressed in the labor-hours required to achieve a certain level of output. Originally, these ratios were expressed in terms of physical output, but as early as 1943, a shift to financial levels of analysis, rather than physical, was suggested (Gold, 1955). Gold called for a departure from an emphasis on the relationship between physical inputs (number of people or labor hours) and physical outputs (number of units produced) in favor of a broader array of measures including financial measures of inputs and outputs, as well as mixtures of the two to serve an organization's purposes. McBeath (1974) noted there have been cases of rapid wage inflation in one industry in which productivity was shown to decline sharply based on financially-based ratios between value

of output and cost of labor. At the same time, figures for the same industry in the same period showed a slight productivity improvement when the ratios were between units of output and the number of people. Thus, the interpretation of labor productivity measures can be problematic.

Economists' reliance on labor productivity is reliance on a partial productivity index (Craig & Harris, 1973). This is considered by many to be a risky approach because it does not explicitly account for other inputs[1] (e.g., materials, capital) (Alluisi & Meigs, 1983; Craig & Harris, 1973). However, as Davis (1951) pointed out very early, even though reliance on labor productivity measurement has led to confusion, such crude measures can be powerful tools of economic appraisal, if joined with an analysis of the factors responsible for the changes discovered in the labor productivity index. The Bureau of Labor Statistics has relied on labor productivity indices for decades to analyze the growth of real gross national product in this country. According to Mahoney (1984) the relative consistency of these indices applied over time and across countries provides advantages that far outweigh their disadvantages. Thus, in macroeconomics, the productivity measures suit the purpose of comparing organizations or societies very well, although such macro measures may not fulfill an individual manager's or organization's purposes of determining the productivity of a particular unit.

Accounting

Many productivity measures used today are those developed by accountants and are financially oriented. These are developed for and relied upon by organizations to make decisions about the worth and effectiveness of business activities. Virtually hundreds of financial ratios can be developed from organizational accounting information (Norman & Bahiri, 1974). Close examination of the ratios developed by accountants shows that they are sales related, and yet the sales value (and thus the profit) may have nothing to do with productivity, but rather may be strongly influenced by supply and demand. Even when selling prices are based on operating costs, it is common practice for profit to be added as a percentage of the total costs (costs which include materials and other outside purchases that already contain the suppliers' profit margins). It becomes obvious that the value of the material used strongly influences the sales and profit margins, and thus the production ratios of an organization.

Industrial Engineering

Saunders (1982) points out that the art and science of the problems of measurement have been practiced by artisans and engineers since the earliest times. As time went on, the methods and equipment used to make measurements improved from early, crude, and imprecise approaches. By the nineteenth century, routine measurement problems (e.g., linear distance, volumes, rates of flow from fixed vessels with standard orifices, conventional height and weight problems, and other problems related to fixed sources with nonvarying elements and parameters) were pretty well established and standardized. However, the industrial engineering measurement problem arose because people became very important to the systems being measured; these systems responded to people and their motivations and responses to various stimuli. An individual's concentration on a task, for example, may vary for dozens of reasons: some physiological, some mental, or some

[1] It should be clarified that labor productivity indices usually reflect the conversion of all materials, depreciation, capital, and services into labor equivalents (using financial terms).

external to the individual. Whatever the reason, the variation causes measurement problems for industrial engineers who strive to establish consistent standards of measurement of human activity.

As a general rule, industrial engineers want to measure those things that would identify waste and lead to waste reduction so that all efforts within the organization are more efficient, more productive, and less wasteful. Industrial engineers not only want to make output greater in terms of the labor-hours expended, but also want higher levels of output or improved quality of output in terms of per dollar of invested capital, per square foot of space occupied, per kilowatt of energy consumed, per mile of transport used, per machine-hour expended, or "per any combination of hundreds of other possible measures that could be used to evaluate whether we are in fact making an improvement in our mode and methods of operation" (Saunders, 1982, p. 1.1.5).

For productivity measurement, the real problem for industrial engineers is the choice of parameters to be used as the proper input and output measures in a particular situation, as there may be no single proper measure for productivity evaluation. Saunders (1982) states that the one fact that must always be paramount is that *the measures used must be relevant to the situation*. It is part of the industrial engineer's job to assess the total impact of any design changes or improvements so that all elements of the system are evaluated in any productivity evaluation.

Mundel (1982) illustrates this point in his discussion of the industrial engineers approach to productivity measurement. He describes eight kinds of measures (including labor productivity, capital productivity, total cost productivity, foreign exchange productivity, and energy productivity) and, through a numerical example, shows how the measurement results differ across the eight approaches. In addition, he discusses the importance of understanding effectiveness issues (described by him as how well the outputs achieve the desired goals of the organization or how much results are obtained because of the outputs), as well as "worth," or the desirability of achieving the specified results. In addition, he describes the essential components of a complete productivity measurement system for an organization's management to use to manage the firm's productivity. While Norman and Bahiri (1972) suggest that engineers equate productivity with efficiency, Saunders' (1982) and Mundel's (1982) views suggest a more comprehensive understanding of the various components inherent in understanding productivity.

Behavioral Approach

Industrial-organizational psychologists, sociologists, and other behavioral theorists emphasize aspects of productivity in which individuals have an interest over which they have control. For example, Guzzo, Jette, and Katzell (1985) performed a meta-analysis of 11 psychologically-based approaches to productivity improvement which included recruitment, training, goal setting, work redesign, monetary incentives, and supervisory methods. The effects were analyzed not only on quality and quantity of output, but on turnover, absenteeism, accidents, and other quality of life issues. Often, the behavioral theorists are really addressing issues relating to the antecedents of productivity gains, or some of the processes within organizations which contribute to or detract from productivity (a more output-oriented concept).

A focus on improving organizational processes is the primary emphasis of Deming (1986). His basic premise is that improvements in quality will improve productivity, because there will be reduced waste, especially because of reductions in the costs of rework. Quality improvements

result from improved organizational processes, and processes are improved through a thorough system of statistical analysis and problem solving activities.

Quality: Definitions and Perspectives

It is important to recognize that when we speak of quality we are not just talking about the quality of the end-product or service. Quality also refers to the quality of the process by which that product or service was created. The following perspectives by Crosby, Deming, and Juran make it clear that quality must permeate the entire organization, and must be a management imperative.

Crosby

Crosby has identified four absolutes of quality: (1) Quality is conformance to requirements, (2) the system of quality is prevention, (3) the performance standard is "Zero Defects" ("Do it right the first time"), and (4) the measurement of quality is the price of nonconformance (Houston, Shettel-Neuber, & Sheposh, 1986; Suarez, 1992).

Crosby defines quality as "conformance to requirements." In doing this, he asserts that quality is not an indication of relative worth. It is either present or not present. Any product that conforms to requirements is a quality product. Any product that does not, is not (Crosby, 1979). To Crosby, requirements are specifications or plans. Quality deteriorates when plans are not followed and specifications not met. "Quality management is a systematic way of guaranteeing that organized activities happen the way they are planned" (Crosby, 1979, p. 22).

Crosby's approach addresses prevention rather than inspection and correction of errors. From his perspective, the purpose of quality management is to set up a system that prevents defects from happening. "To accomplish this, you have to act now on situations which may cause problems some time from now . . ." (Crosby, 1979, p. 29). Crosby speaks of quality as a "vaccine" that must be used to "vaccinate" against the "bacteria" of nonconformance. To Crosby, problems usually arise because product or service requirements are either lacking or in error. He corrects this through the "prevention process" which consists of establishing a requirement, gathering data, comparing the data to the requirement, and taking action on the result. Crosby suggests that this is a continuing activity (Suarez, 1992).

The ultimate goal of Crosby's improvement process is "Zero Defects" or defect free products and services (Crosby, 1979). "Zero Defects" does not mean that the product has to be perfect, but that every individual in the organization is committed to meeting the requirement the first time, every time. Crosby has established a "Zero Defects Day" to provide a forum for management and employees to reaffirm their commitment to quality. However, "Zero Defects" is not just a motivational slogan but an attitude and commitment to prevention rather than taking costly corrective action (Suarez, 1992).

According to Crosby, quality is measured in terms of the price of nonconformance. In other words, the value of quality is the cost of not doing things the way they should be done. To pique management interest in quality control, he draws attention to the high costs that result from nonconformance. To aid managers in tracking these costs, he developed the following formula: Cost of Quality (COQ) = Price of Conformance (POC) + Price of Nonconformance (PONC). The POC refers to the cost of getting things done right the first time. PONC provides information on wasted cost and a "visible" indication of quality as the organization improves (Suarez, 1992).

Crosby has provided several guides and aids to help management implement his "Zero Defects" concept. These include his 14-step quality improvement process and his 5-stage "Quality Management Maturity Grid" (Crosby, 1979). Crosby has also established a guide for establishing a quality education process. The guide is called the "Six Cs." It calls for comprehension, commitment, competence, communication, correction, and continuance in establishing quality within an organization (Crosby, 1984).

Deming

Deming does not define quality in a single phrase. To Deming quality is a relative term that can only be defined by the customer and will change in meaning depending on the customer's needs (Suarez, 1992). Deming cites Shewhart in declaring that the difficulty in defining quality is ". . . to translate future needs of the user into measurable characteristics, so that a product can be designed and turned out to give satisfaction at a price that the user will pay" (Deming, 1986, p. 169). Note, this definition relates to value rather than some absolute standard of quality.

Deming's basic message, as stated in his "chain reaction for quality improvement," is that quality decreases costs and improves productivity (Deming, 1986, p. 3). Quality, as referred to in his "chain reaction," is to be achieved through a continual improvement of processes rather than through mass inspections. According to Deming, inspection as a method of ensuring quality is ". . . too late, ineffective, costly" (Deming 1986, p. 28).

Deming takes a broad-based systems approach to quality that is grounded in his "System of Profound Knowledge." This theoretical system is made up of four interrelated parts: systems, variation, knowledge, and psychology. Profound knowledge is the basic understanding of these four parts and their interactions that is necessary for the effective management of quality. Without profound knowledge, management action can cause ruination (Deming, 1989, 1991, 1993).

Deming emphasizes that organizations should be managed as systems. Within a systems context the performance of any component is to be judged in terms of its contribution to the aim of the system (Deming, 1989, 1991). Optimization of performance only occurs when all departments or subsystems are working together to support the aim of the organization. If departments compete with one another to maximize their individual goals, the aims of the organization as a whole will be suboptimized.

Deming points out that the organization itself exists within an extended system that includes customers and suppliers as well as the entire process of production. "Improvement of quality envelops the entire production line, from incoming materials to the consumer . . . ." (Deming, 1986, p. 4). To optimize production within an organization, the requirements of this extended system must be taken into account.

For Deming, excessive variation is the antithesis of quality. To produce good quality ". . . you must produce outcomes with variation that is both uniform and predictable . . . ." (McConnell, 1988, p. 21). Deming contrasts two causes of variation: "common causes," which are inherent in the system and "special causes," which are exceptions or abnormalities. Walton points out that this distinction carries implications for quality improvement. "A system can best be improved when special causes have been eliminated and it has been brought under statistical control" (Walton, 1986, p. 115).

By "under statistical control" Walton means stabilized: a condition where variation is limited and predictable. In illustrating this point, McConnell relates quality improvement to target shooting. As long as a soldier's shots are widely scattered, it is difficult to adjust the aim. However, once the marksman can produce a stable pattern of hits anywhere on the target, it is relatively easy to adjust the position of the pattern to center on the bull's-eye (McConnell, 1988).

In speaking of knowledge, Deming emphasizes the role of theory and prediction. "We must be guided by theory not figures. Theory is knowledge. Without theory there is no knowledge" (Deming, 1989, 1991). Deming believes that managers should pursue goals similar to those of science (explain, predict, and control) to gain more knowledge about the systems and processes in their organizations. A vehicle he advocates for this purpose is the Shewhart or Plan-Do-Check-Act (PDCA) cycle, an adaptation of the scientific method. The PDCA cycle, involves identifying and planning changes, implementing the changes, checking their effects (through the use of statistical methods), and taking action based on the results. Use of the PDCA cycle allows for the continual improvement of a system or process (Suarez, 1992).

Deming's concerns with psychology involve the dynamics of people in the workplace, group or team performance, learning styles, and cultural change (Suarez, 1992). Deming emphasizes the need for an understanding of people and their reactions to the work environment. He promotes the use of intrinsic motivators that promote dignity and self-esteem (Deming, 1989, 1991). He advocates leadership that drives out fear, creates pride of workmanship, and promotes teamwork (Deming, 1986).

Deming developed "14 Points" as a guide for managers in promoting quality within their organizations. In this guide Deming emphasizes the need for an organizational transformation that, among other things, ceases dependence on mass inspections and instead, improves constantly and forever the system of production and service. The achievement of such a transformation requires participatory leadership that is consistent, as well as constant in purpose, in promoting, and supporting quality. A quality transformation also requires the education and active involvement of a critical mass of people within the organization (Walton, 1986).

Juran

Juran, in his *Quality Control Handbook* defined quality as "fitness for use" (Juran and Gryna, 1988, p. 2.8). More recently, however, he has identified two aspects of quality, "product features" (the characteristics that cause customers to buy the product) and "freedom from deficiencies" (the degree to which the product defects are eliminated) (Juran, 1992). According to Juran, product features impact sales while product deficiencies affect costs. Note that Juran uses the term "product" to refer to services as well as goods (Juran and Gryna, 1988).

Juran notes that confusion has arisen with respect to the cost of quality because of differences in the sense in which the word "quality" is used. ". . . in the sense of grade, . . . higher quality usually does cost more . . . in the sense of freedom from deficiencies, . . . higher quality usually does cost less" (Juran and Gryna, 1988, p. 2.12).

Juran links quality to customers and their usage of products. To Juran, however, customers are not limited to external clients. In his "Triple Role Concept," he indicates that each department within an organization is a customer and supplier for other departments or clients as well as a producer. He illustrates this point with his "Spiral of Progress in Quality" that depicts the sequence of activities carried out by specialized departments to put a product on the market (Juran, 1988).

Juran maintains that interdepartmental cooperation is needed to avoid sub optimization of organizational goals. He advocates "Company-wide Quality Management," a systematic approach for setting and meeting quality goals by upper managers. The approach involves three interrelated, quality-oriented management processes consisting of quality control, quality improvement, and quality planning. These are referred to as the "Juran Trilogy" (Juran, 1988). Quality control is carried out by the operating forces to prevent things from getting worse. This includes dealing with sporadic spikes in variation. Quality improvement is concerned with lowering the cost of poor quality in existing processes and achieving better levels of performance. The purpose of quality planning is to provide the operating force with the means of producing products that will meet customer needs and deal with problems at a more fundamental level than they are addressed in quality improvement.

In conducting quality improvement, Juran advocates a "project by project approach" (Suarez, 1992). Suggestions for projects are solicited each year from all employees by a committee of managers who then select those projects to be undertaken and appoint teams to address each project. Typically, large numbers of teams must be formed, depending on the number of projects that have been selected. Two kinds of teams are formed to work on analyzing problems, the "steering arm" and the "diagnostic arm." The main thrust of these teams is to find and remove the causes of problems. Juran characterizes the process of analyzing problems as two journeys, "the diagnostic journey" (from symptom to cause) and "the remedial journey" (from cause to remedy) (Juran and Gryna, 1988).

Juran's quality improvement process can result in "breakthroughs" which he defines as ". . . improving performance to unprecedented levels . . ." (Juran, 1992, p. 510). According to Juran, breakthroughs can lead to such benefits as: (1) attainment of quality leadership, (2) solution to an excessive number of field problems, and (3) improvement of the organization's public image (Juran, 1964).

In contrast with quality improvement, Juran views quality planning as dealing with problems at a more fundamental level. He draws an analogy where quality improvement is killing alligators, one-by-one, as they crawl up from the swamp. Quality planning would result in draining the swamp (Juran, 1988).

In managing quality planning and improvement, Juran has introduced the concept of the "vital few and trivial many." This concept emphasizes the need to allocate priorities and resources based on the importance of the customer and the impact that the proposed actions will have (Juran, 1992).

Comparison of the Quality Perspectives

Table 1 is a summary of the similarities and differences between the quality management approaches of Crosby, Deming, and Juran along several critical dimensions. As can be seen, the approaches are very similar in most regards (e.g., they all emphasize prevention, transformation, a systems approach, teamwork, supplier/customer relations, the scientific method, management responsibility and commitment, long-term training and education, and continuous improvement). The differences are slight and tend to focus on the precise definition of quality and how quality is measured.

Table 1

Similarities and Differences Among Three Quality Approaches

Comparison	Crosby	Deming	Juran
Definition of Quality			
Conformance to requirements.	X		
Determined by customer needs.		X	
Product features and freedom from deficiencies.			X
Approach to Quality			
Achieve quality through attention to processes rather than by mass inspections and rejection or rework of final products.	X	X	X
Limit focus of attention to quality control through incremental change.	X		X
Focus attention on control and improvement through breakthroughs.			X
Transformation			
Quality approaches are not "programs," but permanent transformations in the way that management operates.	X	X	X
Systems Orientation			
Systems orientation to quality involving the organization and its suppliers and customers.	X	X	X
Emphasize importance of cooperation and teamwork within the organization.	X	X	X
Avoid reward systems that promote competition.		X	X
Supplier/Customer Relationships			
Reduce suppliers.	X	X	X
High emphasis on determining customer needs.		X	X
Application of Scientific Method			
Apply the scientific method to process control or improvement.	X	X	X
Measurement			
Costs are an important quality measure.	X		X
Income is an important quality measure.	X		
Variability and capability of process characteristics are primary quality measures.		X	
Heavy use of statistical techniques.		X	
Management Responsibility			
Management is responsible for most quality problems and for improving the system.	X	X	X
Top management support and commitment is essential.	X	X	X
Provide formal structured procedures for reaffirming commitment to quality.	X		X
Goal Setting			
Ultimate goal is "Zero Defects."	X		
Ultimate goal is continual improvement of processes.		X	
Numerous specific numerical corporate goals.			X

Table 1 (Continued)

Comparison	Crosby	Deming	Juran
Training and Education			
Continuous training and education needed.	X	X	X
Management orientation training in "Zero Defects" concepts.	X		
Training in quality procedures for the entire company hierarchy.		X	X
Management training in quality theory concepts ("Profound Knowledge").		X	
Training for workers primarily in new processes.			X
Formalized training for workers in all processes.		X	
Continuous Improvement			
Pursuit of quality is a long-term process requiring continuous effort.	X	X	X
Continuous effort to meet requirements.	X		
Continual reduction of process variation.		X	
Continuous establishment and deployment of quality goals.			X

General Issues Related to Productivity and Quality

Effectiveness Versus Efficiency

Efficiency is traditionally defined as the use of resources to create outputs, and effectiveness is usually defined as outputs relative to some standard or expectation (Pritchard, 1990). Goodman and Pennings (1977) note that various views on effectiveness exist with respect to the standards or expectations (e.g., they might be in the form of organizational process, or output goals, or the expectations of internal or external groups). Tuttle (1983) concluded that the literature remains confused concerning the distinction between effectiveness and efficiency and that three main precepts exist: (1) Effectiveness is the broader term, with efficiency a dimension of it; (2) productivity is the broader concept, encompassing both efficiency and effectiveness; and (3 efficiency and effectiveness are separate but related concepts.

It is generally agreed among productivity scholars that efficiency is part of the productivity concept; these scholars do not agree, however, on whether effectiveness is also a part of productivity (Pritchard, 1990). Pritchard argues that productivity should include both efficiency and effectiveness, and points out that either efficiency or effectiveness measures used alone can be dysfunctional to the organization. The view taken in this report is that effectiveness is the broader concept, and efficiency and productivity are components of effectiveness (other components include financial performance, stakeholder relations, and resource development). The reasoning is that, for an organization to be effective (i.e., fulfill its mission and meet its goals), it must be productive, manage its resources, keep its stakeholders happy, balance its books, and run an efficient operation (see Nebeker et al., 1996; Tatum et al., 1996, for further development of this viewpoint).

Levels of Analysis

The foregoing discussion raises another issue in productivity measurement—the level-of-analysis issue. Economists focus on comparing aggregations of organizations or even societies; accountants, industrial engineers, and many behavioral scientists usually focus on single organizations or segments of an organization, while industrial psychologists often focus on the individual employee. Total quality management focuses on the separate and combined processes in an organization; measures of effectiveness may relate to organizational sub-processes, unit outputs, or organization-wide outputs. The productivity scholar's background or discipline may bias his or her level of analysis, but measurement and explanation of productivity require a multilevel approach anyway. Even if organizations are the central focus of inquiry or analysis, lower and higher aggregation levels can be examined in order to understand productivity more completely.

Quantity Versus Quality

Productivity is usually couched in quantitative terms (e.g., the number of units produced divided by the number of resources used). The value of the outputs or the quality of the inputs has not always been considered as an integral part of typical productivity indices. In the past, quality was expressed in terms of meeting specification or tolerance limits. If the product met the design specifications, then it passed a certain "quality threshold" and was considered to be a "quality product." Deming (1986) noted the limitations of this traditional approach to quality, and argued for a new approach for dealing with quality issues. In brief, the approach advocated by Deming and others (e.g., Crosby, 1979, Juran, 1988) is to incorporate quality considerations into every step of the production (or service delivery) process, from the acceptance of the incoming materials to the delivery of the product or service to the customer. With this newer approach, quality is not something that is checked only after the product has been made, but something that is built into the product. Poor quality is not something you hire inspectors to find, it is something that the production system is designed to prevent. Quality is not determined by design engineers, quality is determined by the customer's requirements and the product's "fitness for use." Most important, quality is a *never-ending pursuit to constantly improve the production (or service) process and the quality attributes of the product or service*. Given this orientation, it is clear that productivity is a meaningless concept if it refers only to the quantity of outputs and inputs. Productivity must incorporate some notion of the quality of the outputs and inputs.

Integrating Gain Sharing and Total Quality

The Compatibility of Productivity Gain Sharing and Total Quality Management

After all the dust settles, the core idea expressed by the different perspectives is that productivity is the ratio of outputs (goods and services) to inputs (resources such as labor, material, energy, etc.), and that quality is how well the product or service meets the specified requirements. PGS has, as the name implies, focused on methods for increasing productivity in organizations. TQM, as the name implies, has focused on improving quality. As Landau and Tatum (1992) point out, however, the two approaches to improving organizational effectiveness are quite compatible. This is because the concepts of productivity and quality are intimately related. The traditional view has been that the pursuit of higher productivity (greater output/input ratio) comes at the expense of quality; or, conversely, higher quality leads to lower productivity. Crosby, Deming, Juran, and

others have shown, however, that this traditional view is wrong in the great majority of cases. When quality refers to "total quality" (i.e., quality of the process as well as quality of the product), the never-ending pursuit of quality actually raises productivity rather than lowers it. Nowhere has this been more convincingly demonstrated than in Japan.

The Japanese automotive industry, for example, has spent years improving the quality of its automobile manufacturing processes. As a result, they have practically eliminated rework, reduced waste and scrap, lowered the downtime from equipment failures, streamlined procedures, enhanced the quality of incoming materials, and increased the uniformity of parts and sub-assemblies. All of these process improvements have led to an increase in productivity and enhanced the quality of the end product. The lesson here is that the road to increased productivity is paved by quality, and that any effort to boost productivity must adopt the principles of total quality. This is exactly what modern versions of PGS do by emphasizing continuous improvement, stressing customer relations, focusing on managements responsibilities, adopting employee involvement structures, and developing precise measurement systems (Landau & Tatum, 1992). In addition, PGS also recognizes that employees need to be rewarded for their improvement efforts, and so financial bonuses are paid out whenever the organizations performance increases.

The Definition of Productivity: Revisited

Because productivity and quality are related terms, the traditional definitions of productivity as simply outputs divided by inputs are not adequate. What is really needed in today's economy is the efficient use of resources to produce high quality products and services. If we define productivity not only in terms of the quantity of outputs per units of inputs, but also in terms of the quality of the output, then both the productivity and quality imperatives are met at the same time. In other words, an organization is not productive unless it increases the output to input ratio *and* produces high quality outputs. Another way of expressing this is to define productivity as the ratio of the *value of outputs* to the inputs. If the value (quality) of the outputs is part of the definition of productivity, then PGS and TQM do not conflict, but are in fact compatible.

This definition of productivity that incorporates the value (quality) of the outputs is, in a sense, compatible with reports on U.S. productivity from the Bureau of Labor Statistics (Bureau of Labor Statistics, 1992). A frequently cited statistic is the constant-dollar value of shipments, sales, or revenue data divided by labor hours for some period (e.g., 1 year). This dollar value used as an index of output reflects, in a crude way, the value (quality) of the output (i.e., what the output is worth). Obviously, dollar value is far from a perfect indication of quality (even when adjusted for inflation), but it does reflect, to some degree, the value (quality) of the outputs.

Background to the Productivity Problem

Now that we have discussed the many definitions and points of view related to productivity and quality, we turn to a discussion of the nature and causes of the decline in productivity growth in the U.S. Looking at the decline in productivity growth from a national perspective is important because what it means is that, on the average, productivity growth for individual organizations is also declining. Table 2 presents comparative international labor productivity growth data. Over the 1960-1988 period, the rate of productivity growth declined in all nations listed. The United States had the lowest growth rate for each of the periods.

Table 2

Trends in International Productivity Growth[a]

Country	1960-1970 (%)	1970-1980 (%)	1980-1988 (%)
Canada	3.9	2.3	1.6
France	7.0	4.7	3.2
Italy	9.6	4.1	2.6
Japan	13.3	5.7	2.3
United Kingdom	4.2	3.2	2.1
United States	2.6	1.1	1.5
West Germany	6.9	4.7	2.2

[a]Data compiled from Gordon (1990, Appendices A and B).

Figure 1 shows the rate of U.S. labor productivity growth for the period 1947-1992 (based on figures from the Bureau of Labor Statistics, June 1993). Figure 1 shows that up until 1969, annual productivity growth was 3.2%. After 1969, productivity growth fell off dramatically.

Figure 2 shows a comparison of compensation per hour (without adjusting for the employment cost index) to real earnings (compensation adjusted by the employment cost index). Figure 2 shows that real earnings follow the productivity growth rate (output per hour) very closely, and that real earnings have declined since 1969.

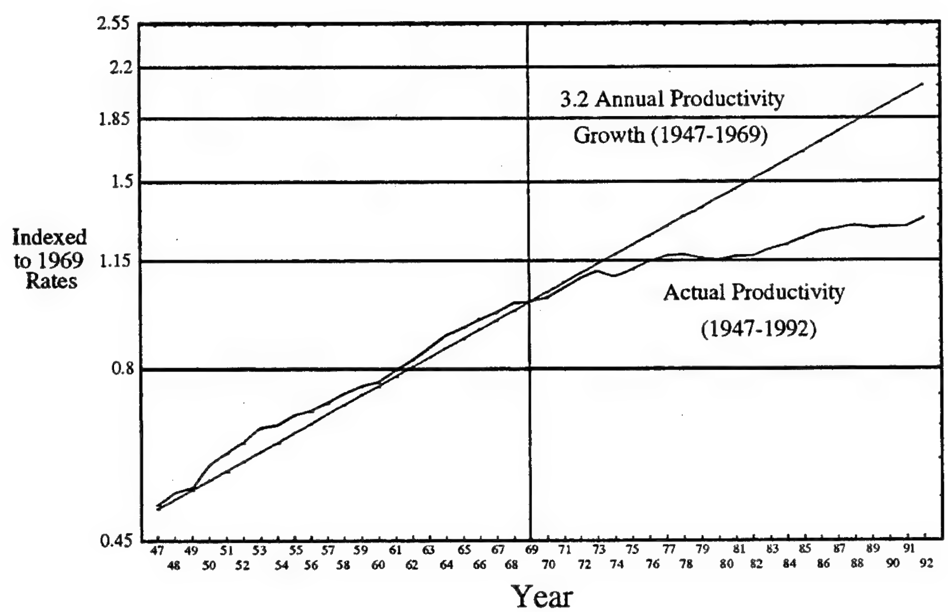

Figure 1. U.S. productivity (output per hour): 1947 to 1992.

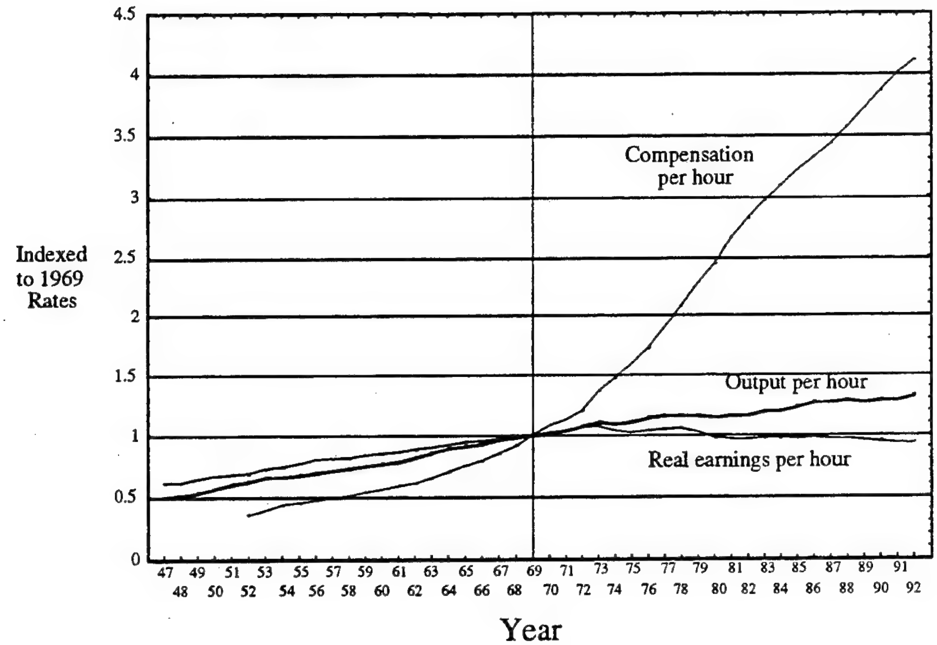

Figure 2. Wages, real earnings, and output per hour: 1947 to 1992.

Table 3 illustrates changes in the rate of productivity growth for certain periods, compares manufacturing and nonmanufacturing rates, and separates labor productivity, which includes the effects of capital growth, from that which does not. The numbers in Table 3 show that the productivity growth slowdown continues to be a serious problem, but not as severe as it was in the 1970's. Notably, as shown in Table 3, manufacturing has been quite strong compared to the nonmanufacturing sector. Unfortunately, the nonmanufacturing sector is about three times larger than the manufacturing part of the economy. Also, two thirds of the productivity recovery occurred in the computer industry (Gordon, 1990). The bottom half of Table 3 displays the growth rate of multifactor productivity, obtained from output per hour productivity by subtracting the contribution of growth in capital per worker hour. These numbers suggest that slower growth in capital input contributes only slightly to the overall productivity growth problem.

Improvements in our standard of living in terms of material goods or services depends directly upon our ability to improve productivity in producing those goods and services. Such improvement is critical to lessening inflationary pressures on prices to consumers for the long term. A high rate of growth in labor productivity allows wages and salaries to be increased without raising unit labor costs and prices of goods and services. More efficient use of energy, capital, and materials makes it possible to offset the rising prices of these inputs. By diminishing long-term inflationary pressures through productivity improvement, we can reverse the erosion of real incomes and living standards (Burnham, 1982).

Declining productivity affects our way of life, not just because of its real effects on inflation and thus on our standard of living, but on our attitudes toward our country and its place in the world. A Lou Harris poll commissioned by a U.S. insurance firm and reported by Tuttle (1983) illustrated that the vast majority of Americans polled believe that unless our productivity growth

Table 3

Average Annual Aggregate Productivity Growth (Percent per Year)

Measure	1948-1973	1973-1979	1979-1987	Change: 1948-1973 to 1973-1987
Output/hour				
All Business	2.94	0.62	1.32	-1.92
Nonfarm business	2.45	0.48	1.11	-1.61
Manufacturing	2.82	1.38	3.39	-0.30
Nonmanufacturing	2.32	0.16	0.33	-2.07
Multifactor productivity[a]				
All Business	2.00	0.10	0.61	-1.61
Nonfarm business	1.68	-0.08	0.45	-1.46
Manufacturing	2.03	.52	2.56	-0.35
Nonmanufacturing	1.55	-0.29	0.28	-1.85

[a]Gordon (1990) defines multifactor productivity as "the growth rate of output per hour of work, minus the contribution to output of the growth in the quantity of other factors of production per hour of work, notably capital, but sometimes including energy, raw materials, or other factors of production" (p. G6).

improves, we will be unable to meet the country's health, educational, and social welfare goals. Over 70% believe that international respect and influence will decline, along with our standard of living. Recent recessionary worries since the Persian Gulf war demonstrate how lack of consumer confidence inhibits economic recovery.

Causes of the Productivity Problem

The productivity problem is a combination of many factors. Some of these factors are more "macro" in focus and some more at the level of the individual firm. Economists focus on the macro factors such as the changing work force, government regulations, availability of capital, tax laws, investment policies, and trade legislation. Certainly, these macro causes affect the decisions that managers make for their firms. National policy-related decisions should be made that can positively impact productivity improvement in our free-market system. However, many charge that managers overemphasize the role of these more uncontrollable, macro factors. These authors point out that good policies are not a substitute for poor management practices and that changes at the national level may not be sufficient to reverse the productivity decline (Donnelly et al., 1987; Sink, 1985; Tuttle, 1983). Instead, productivity improvement needs to be viewed as a major responsibility of managers themselves because "ultimately the productivity battle will be fought and won in the individual organization in the individual workplace" (Tuttle, 1983, p. 480). Factors contributing to declining productivity which are in management's purview include: (1) lack of managerial focus, (2) excessive layers of management, (3) managerial focus on short-term results, (4) measurement difficulties, (5) lack of productivity goals, (6) aging plants, (7) unions, (8) technological issues, including low R&D expenditures.

In recent years, management has tended to focus on mergers, acquisitions, and increasing market share instead of focusing attention on ways and methods to improve productivity within their firms. (While it might be argued that mergers, acquisitions, and increased market share

improve the profitability of a firm and may be related to productivity, the point here is that these managerial efforts are not pointed specificaly at productivity improvement.)

Few firms explicitly state productivity improvement as a goal, and even fewer have specific productivity goals for each aspect of the business (Sink, 1985; Donnelly et al., 1987). Management is under pressure to perform in the short term and often avoids expenditures and efforts that, while having potential long-term benefits, will have negative effects on the short-term bottom line. When management does focus its attention on methods and practices to use within the firm aimed at productivity improvement, these methods often emphasize technological improvements, reduction of hierarchical levels, and wage concessions in union contracts (Donnelly et al., 1987).

Ruch (1982) has suggested five organizational methods that management can use to increase productivity. Figure 3 summarizes these methods (the figure defines productivity as an output/input ratio).

1.	$\frac{++}{+}$	Output increases faster than input *"managed growth"*
2.	$\frac{-}{--}$	Input decreases more than output (e.g., phasing out an old product, losing an inefficient plant) *"managed decline"*
3.	$\frac{0}{-}$	Producing the same output with fewer inputs *"cost reduction"*
4.	$\frac{+}{0}$	More outputs from the same inputs *"working smarter"*
5.	$\frac{+}{-}$	The ideal; maximum increase in the ratio *by a combination of the above*

Key: 0 = no change in factor; + = increase in factor; – = decrease in factor.

Figure 3. Five ways to increase productivity.

Investing in new technology might fit Ruch's "managed growth" (Method 1) if the cost of the new technology is more than offset by gains in outputs; gaining wage concessions might be an example of Method 3 in the figure; and reducing levels of hierarchy probably is a good example of Method 2. The total quality approaches of Deming and others would emphasize the use of Methods 4 and 5.

However, whether any or all of these methods have the intended effect on productivity assumes that the causes of the productivity problem are defined or known. Also, the effects of these methods assumes that management has decided that at least some of these known causes are within their

control, such that productivity improvements can be made. Of course, all of this assumes that management has defined productivity and developed measures of it. As Riggs and Felix (1983) said, "A productivity program without benchmarks is a race without a timer" (p. 40).

Herein lies the problem we have tried to address in this report: What is productivity? We have argued that productivity is the effective and efficient use of resources to generate the highest quality goods and services. Any method that increases the quantity and quality of the output for a given set of resources will improve productivity and will increase one's competitive position. Of course, as Sink (1985) and Nebeker et al. (1996) have noted, productivity is only one component of an organization's total performance. Other components of performance (e.g., profitability, stakeholder relations, resource development) must also improve if the organization is to survive over the long haul, and methods must be devised for improving these components along with increasing productivity.

Conclusion

Although there is much confusion surrounding the topic of the definition and measurement of productivity and quality, the importance of each is evident in the U.S. and the world. A plethora of definitions of, purposes for, and approaches to the measurement of productivity and quality exists. Many scholars have developed measurement systems reflecting their perspectives on productivity and quality (Craig & Harris, 1973; Mundel, 1982; Nebeker & Tatum, 1996; Nebeker et al., 1996; Pritchard, Jones, Roth, Stuebing, & Ekeberg, 1989; Riggs & Felix, 1983; Sink, 1985; Tuttle and Weaver, 1986). Pritchard (1990) describes many of these in detail and provides a summary of the main characteristics of each. Nebeker and Tatum have also developed measurement approaches that incorporate other components of performance (e.g., stakeholder relations, resource development) besides productivity and quality (Nebeker & Tatum, 1996; Nebeker et al., 1996).

This report has attempted to synthesize the productivity and quality literature and develop an integrated definition and approach. We hope that this integration makes it clear that Productivity Gain Sharing and Total Quality Management, rather than being competing approaches to organizational effectiveness, are actually very compatible in their goals and methods (Landau & Tatum, 1992). Productivity and quality improvement need to be a primary focus within organizations and society so that our standard of living can continually improve and our stature as a nation can be sustained.

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